VISIT…

5 Reliability Management

5.1 INTRODUCTION

Reliability management has become an important element of reliability engineering because of various factors including system complexity, sophistication, and size; demanding reliability requirements; and cost and time constraints. Reliability management is concerned with the direction and control of an organization's reliability activities such as developing reliability policies and goals, facilitating interactions of reliability manpower with other parts of the organization, and staffing.

The history of reliability management can be traced back to the late 1950s when the U.S. Air Force developed a reliability program management document (i.e., Exhibit 58-10) [1]. Subsequently, the efforts of the U.S. Department of Defense to develop requirements for an organized contractor reliability program resulted in the release of the military specification MIL-R-27542 [2].

Many publications directly or indirectly relating to reliability management have appeared [3]. This chapter presents various important aspects of reliability management.

5.2 GENERAL MANAGEMENT RELIABILITY PROGRAM RESPONSIBILITIES

General management plays an important role in the success of a reliability program by fulfilling its responsibilities in an effective manner. Some of its responsibilities are as follows [4]:

- Developing appropriate reliability goals.
- Providing appropriate funds, manpower, scheduled time, and authority.
- Establishing an effective program to fulfill set reliability objectives or goals and eradicating existing shortcomings.
- Developing a mechanism for accessing information concerning current reliability performance of the organization with respect to its operations and products.
- Monitoring the program regularly and taking appropriate corrective measures with respect to associated policies, procedures, organization, and so on.

5.3 A METHOD FOR ESTABLISHING RELIABILITY GOALS AND GUIDELINES FOR DEVELOPING RELIABILITY PROGRAMS

When working from preestablished reliability requirements, it is essential to develop appropriate reliability goals. This involves reducing the requirements to a series of subgoals. The steps of a useful method for establishing reliability goals are shown in Figure 5.1 [5].

© 2006 by Taylor & Francis Group, LLC

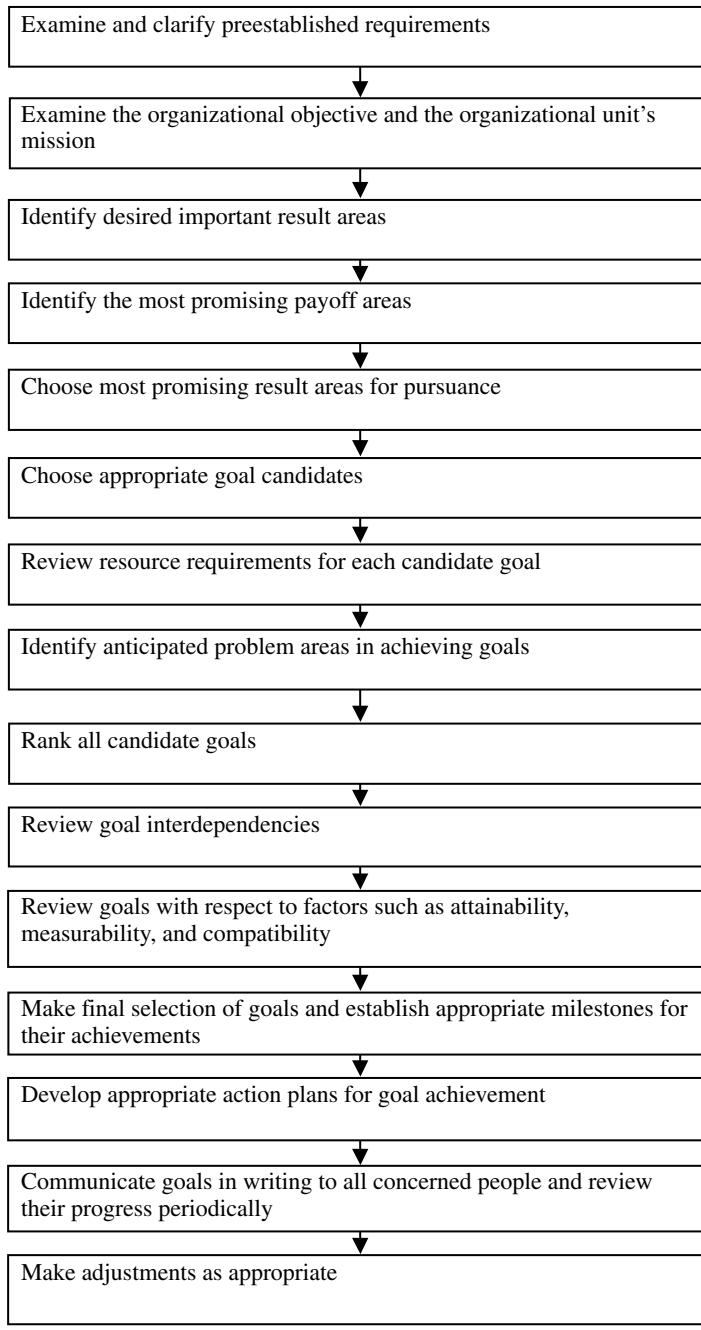
Examine and clarify preestablished requirements
Examine the organizational objective and the organizational unit's mission
Identify desired important result areas
Identify the most promising payoff areas
Choose most promising result areas for pursuance
Choose appropriate goal candidates
Review resource requirements for each candidate goal
Identify anticipated problem areas in achieving goals
Rank all candidate goals
Review goal interdependencies
Review goals with respect to factors such as attainability, measurability, and compatibility
Make final selection of goals and establish appropriate milestones for their achievements
Develop appropriate action plans for goal achievement
Communicate goals in writing to all concerned people and review their progress periodically
Make adjustments as appropriate

FIGURE 5.1 Steps of a method for developing reliability goals.

© 2006 by Taylor & Francis Group, LLC

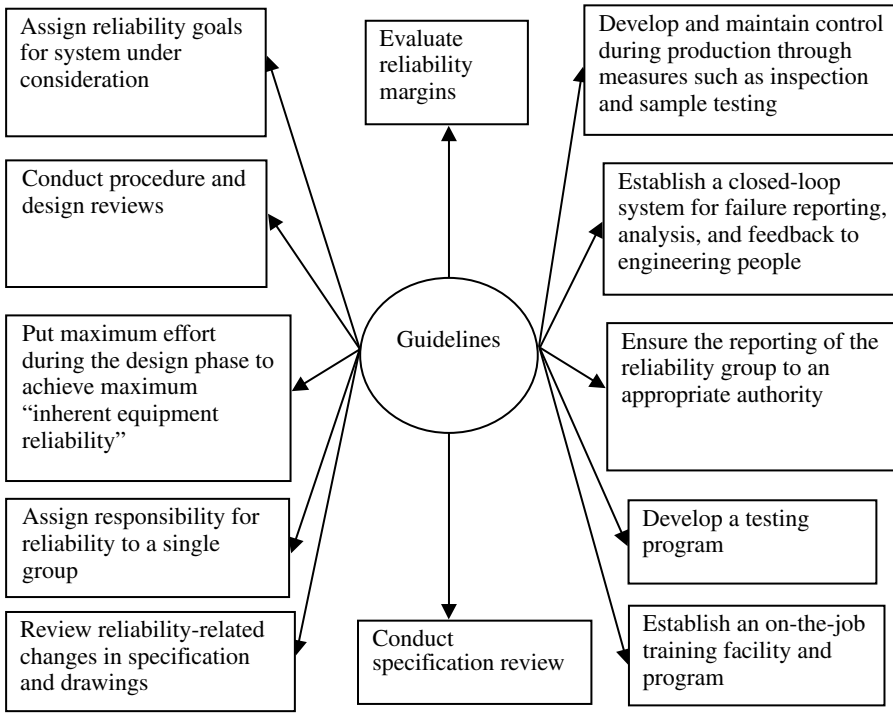
Assign reliability goals for system under consideration
Evaluate reliability margins
Develop and maintain control during production through measures such as inspection and sample testing
Conduct procedure and design reviews
Establish a closed-loop system for failure reporting, analysis, and feedback to engineering people
Guidelines
Put maximum effort during the design phase to achieve maximum "inherent equipment reliability"
Ensure the reporting of the reliability group to an appropriate authority
Assign responsibility for reliability to a single group
Develop a testing program
Review reliability-related changes in specification and drawings
Conduct specification review
Establish an on-the-job training facility and program

FIGURE 5.2 Useful guidelines for developing reliability programs.

Various guidelines have appeared in the published literature for developing reliability programs. Figure 5.2 presents 12 guidelines for developing reliability programs that appeared in the military specification MIL-R-27542 [6].

5.4 RELIABILITY AND MAINTAINABILITY MANAGEMENT TASKS IN SYSTEM LIFE CYCLE

To obtain the desired level of reliability of a system in the field environment, a series of management tasks with respect to reliability and maintainability must be performed throughout the system life cycle. The system life cycle may be divided into four phases as shown in Figure 5.3 [7]. The reliability- and maintainability-related management tasks involved in each of these phases are presented below.

5.4.1 Concept and Definition Phase

This is the first phase of the system life cycle, in which system requirements are established and the basic characteristics are defined. During this phase various reliability- and maintainability-related management tasks are performed.

Some of these tasks are: (a) defining the system capability requirements, management controls, parts control requirements, and terms used; (b) defining the

© 2006 by Taylor & Francis Group, LLC

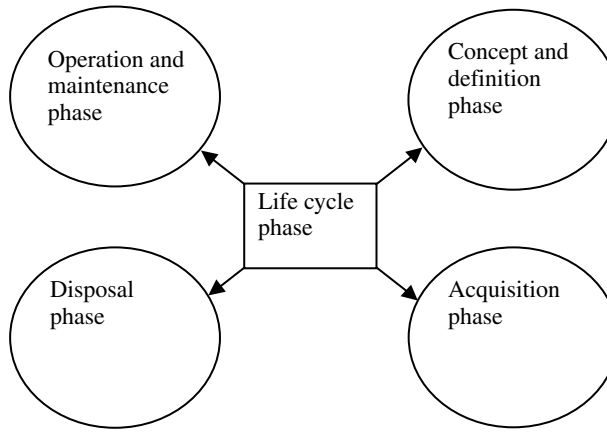

FIGURE 5.3 System life cycle phases.

system reliability and maintainability goals in quantitative terms; (c) defining system environmental factors during its life cycle; (d) defining hardware and software standard documents to be used to meet reliability and maintainability requirements; (e) defining constraints proven to be harmful to reliability; (f) defining data collection and analysis needs during the system life cycle; (g) defining methods to be used during the design and manufacturing phase; (h) defining the management controls required for documentation; (i) defining the combination of machines, facilities, manpower, and tools required to produce the design and its assemblies to the stated specifications; (j) defining system safety requirements; and (k) defining the basic maintenance philosophy.

5.4.2 Acquisition Phase

This phase is concerned with activities related to system acquisition and installation as well as planning for the eventual support of the system under consideration. Many reliability- and maintainability-related management tasks are involved in this phase. Some of these tasks are as follows:

- Define all system technical requirements.
- Define the major design and development methods to be employed.
- Define the demonstration requirements.
- Define all the reliability and maintainability requirements to be satisfied.
- Define all the documents required as part of the final product, system, or equipment.
- Define the kind of evaluation methods to be used to assess the system.
- Define the kind of reviews to be performed.
- Define the kind of data the manufacturer must provide to the customer.
- Define the meaning of a degradation or failure.
- Define the cost restraints and the life cycle cost information to be developed.

© 2006 by Taylor & Francis Group, LLC

TABLE 5.1
Reliability- and Maintainability-Related Management Tasks Associated with the Operation and Maintenance Phase

No.	Task
1	• Collect, monitor, and analyze reliability and maintainability data
2	• Manage and predict spare parts
3	• Establish failure data banks
4	• Provide adequate maintenance tools and test equipment
5	• Prepare engineering and maintenance documents
6	• Review the documentation with respect to any engineering change
7	• Develop engineering change proposals
8	• Provide adequate manpower
9	• Develop maintenance support for the various levels of maintenance

- Define the type of field studies, if any, to be conducted.
- Define the controls to be exercised by both the manufacturer and the customer during this phase.
- Define the kind of future logistics required (i.e., during initial acquisition and in-service period).

5.4.3 Operation and Maintenance Phase

This phase is concerned with tasks associated with the maintenance activity, management of the engineering, and support of the system during its entire operational life. Some of the reliability- and maintainability-related management tasks associated with this phase are presented in Table 5.1.

5.4.4 Disposal Phase

This phase is concerned with tasks that are required to remove the system and all its nonessential supporting material. Two of the reliability- and maintainability-related management tasks involved in this phase are calculating the final system life cycle cost and the reliability and maintainability values. The resulting life cycle cost takes into consideration the disposal action cost or income. The reliability and maintainability values are computed for the buyer of the used system as well as for application in the procurement of similar systems.

5.5 RELIABILITY MANAGEMENT TOOLS AND DOCUMENTS

Reliability management uses a variety of tools and documents. Some examples of these tools are configuration management, value engineering, and critical path method. Similarly, some of the documents used by reliability management are the

© 2006 by Taylor & Francis Group, LLC

reliability manual, international and national specifications and standards, policy and procedure documents, plans and instructions, and reports and drawings [7].

Some of the above items are discussed below.

5.5.1 Configuration Management

During the development of an engineering system or product many changes may occur; these changes may be concerned with product performance, weight, size, appearance, and so on. Configuration management is a useful tool to assure the customer and the manufacturer that the end product will fully satisfy the contract specification. Thus, configuration management is the management of engineering requirements that defines the engineering product or system as well as changes thereto [8].

The history of configuration management can be traced back to 1962, when the U.S. Air Force released a document entitled "Configuration Management During the Development and Acquisition Phases," AFSCM 375-1 [9]. Today configuration management is well known in the industrial sector, and its advantages include reduction in overall cost, effective channeling of resources, facilitation of accurate data retrieval, elimination of redundant efforts, formal establishment of objectives, and precisely identified final product.

Configuration management is described in detail in Reference 10.

5.5.2 Value Engineering

Value engineering is a systematic, creative technique used to accomplish a necessary function at the minimum cost [11]. Historical records clearly indicate that the application of the value engineering approach has returned somewhere between $15 and $30 for each dollar spent [12]. The financial returns from the application of this concept are very promising.

The history of the value engineering concept can be traced back to 1947, when General Electric Company assigned Lawrence D. Miles a project to develop methods for reducing costs through material substitution or changes in design or production methods [7].

There are many areas in which value engineering is useful: identifying areas requiring attention and improvement, prioritizing, serving as a vehicle for dialogue, increasing the value of good and services, and generating new ideas to solve problems. It also serves as a useful tool to determine alternative solutions to a concern, a useful procedure for assigning dollars on high-value items, a means to document rationales behind decisions, and a useful approach for determining and quantifying intangibles [12].

Additional information on value engineering is available in Reference 13.

5.5.3 Critical Path Method

The critical path method (CPM) along with the program evaluation and review technique (PERT) is widely used for planning and controlling projects. It was developed by E.I. DuPont de Nemours and Company in 1956 for scheduling

© 2006 by Taylor & Francis Group, LLC

TABLE 5.2
Topics Covered in a Reliability Manual

No.	Topic
1	• Company-wide reliability policy
2	• Organizational structure and responsibilities
3	• Relationship with suppliers and customers
4	• Product design phase procedures from the standpoint of reliability
5	• Effective reliability methods, models, etc.
6	• Reliability test and demonstration approaches and procedures
7	• Failure data collection and analysis methods and procedures to be followed

design- and construction-related activities [14]. The following general steps are associated with this method:

- Break down the project under consideration into individual tasks or jobs.
- Arrange the jobs or tasks into a logical network.
- Estimate the duration time of each task or job.
- Develop a schedule.
- Highlight jobs or tasks that control the completion of the project.
- Redistribute resources and funds to improve the schedule.

Some of the advantages of the CPM are that it is useful to determine project duration systematically, show interrelationships in work flow, improve communication and understanding, identify critical work activities for completing the project on time, monitor project progress effectively, and determine the need for labor and resources in advance. It is also useful in cost control and cost saving [15].

CPM is described in detail in Reference 16.

5.5.4 Reliability Manual

This is the backbone of any reliability organization. Its existence is absolutely necessary for any organization irrespective of its size. A typical reliability manual covers topics such as those presented in Table 5.2 [7].

5.6 RELIABILITY DEPARTMENT FUNCTIONS AND TASKS OF RELIABILITY ENGINEER

A reliability department performs a variety of reliability-related functions. Some of these are developing reliability policy, plans, and procedures; providing reliability-related inputs to design proposals and specifications; carrying out reliability allocation and prediction; training reliability manpower; conducting reliability-related research; auditing reliability-related activities; carrying out reliability demonstration and failure data collection and reporting; monitoring the reliability activities of subcontractors (if any), monitoring reliability growth, conducting specification and

© 2006 by Taylor & Francis Group, LLC

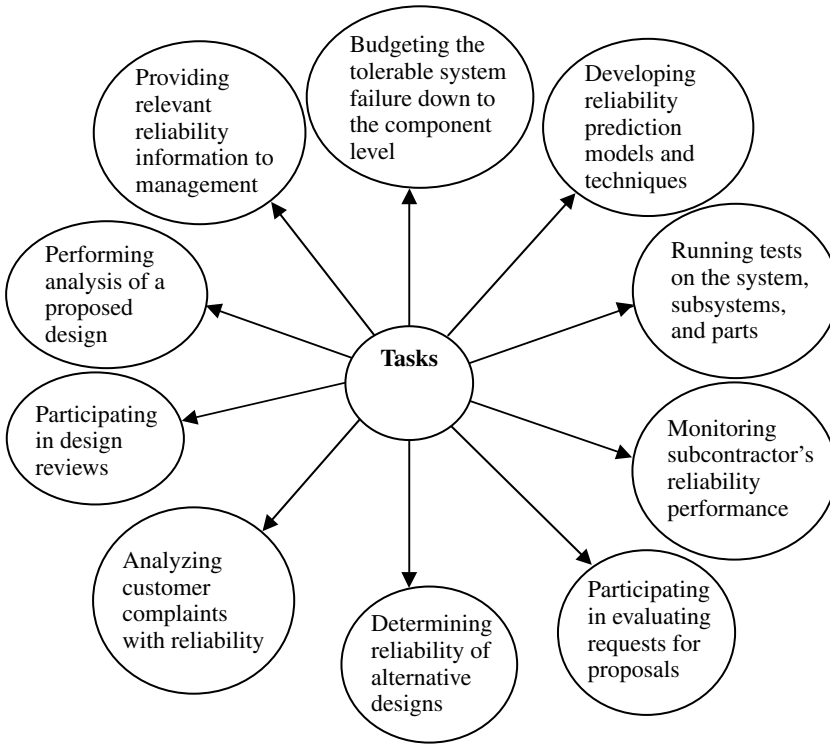
Tasks
Budgeting the tolerable system failure down to the component level
Developing reliability prediction models and techniques
Providing relevant reliability information to management
Performing analysis of a proposed design
Running tests on the system, subsystems, and parts
Participating in design reviews
Monitoring subcontractor's reliability performance
Analyzing customer complaints with reliability
Determining reliability of alternative designs
Participating in evaluating requests for proposals

FIGURE 5.4 Important tasks of a reliability engineer.

design reviews with respect to reliability; consulting on reliability matters; and conducting failure data analysis [2].

A reliability engineer performs various types of tasks. Some of the important ones are shown in Figure 5.4 [2].

5.7 PITFALLS IN RELIABILITY PROGRAM MANAGEMENT

Past experiences indicate that many reliability program uncertainties and problems are the result of pitfalls in reliability program management. These pitfalls occur in many areas, as shown in Figure 5.5 [17]. A typical example of the pitfalls that occur in reliability testing is the delay in starting the reliability-demonstrating testing. Similarly, two typical examples of the pitfalls in the reliability organization areas are having several organizational tiers and many persons with authority to make commitments without any dialogue and coordination.

Many programming-related pitfalls require careful attention. One example of these pitfalls is the assumption that each person associated with the program clearly understands the specified reliability requirements.

© 2006 by Taylor & Francis Group, LLC

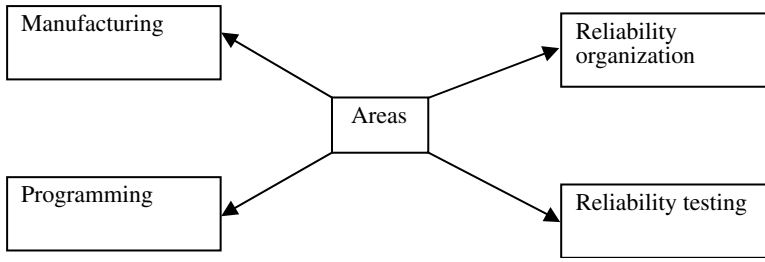

FIGURE 5.5 Main areas of pitfalls in reliability program management.

Finally, an example of the manufacturing phase pitfalls is the authorization of substitute parts, without paying much attention to their effect on reliability, by parts buyers or others when the parts acquisition lead time is incompatible with the system manufacturing schedule.

All in all, the occurrence of pitfalls such as these can only be avoided by an effective reliability management team.

5.8 PROBLEMS

1. Write an essay on reliability management.
2. Discuss the general management reliability program responsibilities.
3. Describe a method for developing reliability goals.
4. List at least ten useful guidelines for developing reliability programs.
5. Discuss reliability and maintainability management tasks for the system acquisition phase.
6. Discuss the following items:
   - Configuration management
   - Value engineering
7. Discuss the topics covered in a reliability manual.
8. List at least ten important functions of a reliability department.
9. Discuss important tasks of a reliability engineer.
10. Discuss reliability program management pitfalls.

REFERENCES

1. Austin-Davis, W., Reliability management: a challenge, *IEEE Transactions on Reliability*, 12, 6–9, 1963.
2. Dhillon, B.S., Engineering reliability management, *IEEE Journal on Selected Areas in Communications*, 4(7), 1015–1020, 1986.
3. Dhillon, B.S., *Reliability and Quality Control: Bibliography on General and Specialized Areas*, Beta Publishers, Gloucester, Ontario, Canada, 1992.
4. Heyel, C., *The Encyclopaedia of Management*, Van Nostrand Reinhold, New York, 1979.

© 2006 by Taylor & Francis Group, LLC

5. Grant Ireson, W., Coombs, C.F., and Moss, R.Y., Eds., *Handbook of Reliability Engineering and Management*, McGraw-Hill, New York, 1996.
6. Karger, D.W. and Murdick, R.G., *Managing Engineering and Research*, Industrial Press, New York, 1980.
7. Dhillon, B.S. and Reiche, H., *Reliability and Maintainability Management*, Van Nostrand Reinhold, New York, 1985.
8. Feller, M., Configuration management, *IEEE Transactions on Engineering Management*, 16, 64–66, 1969.
9. *Configuration Management During the Development and Acquisition Phases*, AFSCM 375-1, Department of the Air Force, Washington, DC, 1962.
10. Hass, A.M.J., *Configuration Management Principles and Practice*, Addison-Wesley, Boston, 2003.
11. *Engineering Design Handbook: Value Engineering*, AMCP 706-104, Department of Defense, Washington, DC, 1971.
12. Demarle, D.J. and Shillito, M.L., Value engineering, in *Handbook of Industrial Engineering*, Selvendy, G., Ed., John Wiley & Sons, New York, 1982, pp. 7.3.1–7.3.20.
13. Younker, D.L., *Value Engineering: Analysis and Methodology*, Marcel Dekker, New York, 2003.
14. Riggs, J.L. and Inoue, M.S., *Introduction to Operations Research and Management Science: A General Systems Approach*, McGraw-Hill, New York, 1975.
15. Lomax, P.A., *Network Analysis: Application to the Building Industry*, The English Universities Press, London, 1969.
16. Antill, J.M., *Critical Path Methods in Construction Practice*, John Wiley & Sons, New York, 1982.
17. Thomas, E.F., Pitfalls in reliability program management, *Proceedings of the Annual Reliability and Maintainability Symposium*, 369–373, 1976.

© 2006 by Taylor & Francis Group, LLC